Expert System for Management of Urinary Incontinence in Women

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The purpose of this nursing informatics and outcomes research study was to determine the effectiveness of an expert system for disseminating knowledge to ambulatory women health care consumers with urinary incontinence. Clinical knowledge from the Agency for Health Care Policy and Research (AHCPR) patient guideline for urinary incontinence and research literature for behavioral treatments provided the knowledge base for the expert system.
Two experimental groups (booklet and expert system) and one control group were utilized. Study results suggest the use of an expert system as one effective communication means for disseminating clinical information in an advisory capacity to ambulatory women with urinary incontinence.

INTRODUCTION

Health care consumers are demonstrating an increased interest in the delivery and quality of health care. For informed health decisions, consumers need to become aware of, receive, accept, and utilize information. Computer technology is available for communicating and disseminating information from experienced and knowledgeable clinicians to health care consumers. The study examines use of computer technology in the form of an expert system as a dissemination strategy for informing health care consumers.

The Agency for Health Care Policy and Research (AHCPR) developed a clinical practice guideline for urinary incontinence intended to assist health care consumers become aware of and participate in treatment decisions for their own care. Guideline authors reported the incidence of urinary incontinence for noninstitutionalized persons older than 60 to be from 15 percent to 30 percent, with women twice as likely to have incontinent episodes.[1] The potentially serious consequences for those accustomed to functional independence were also reported.[2]

Behavioral techniques, as treatment alternatives for urinary incontinence, were stated in the AHCPR guideline and research literature as pelvic muscle exercises (PME) for stress incontinence and bladder training for urge incontinence.[1,3,4,5,6,7]

Mason reported measuring behavior changes as an outcome variable.[8] To fully participate in health care choices and behavior changes, consumers need information about alternatives including risks and benefits.[9]

Three previous studies measured patient behavior changes following interaction with a computer-based education or consultation program. A study by Rubin et al. used a computer game program as an educational intervention for children with an educational intervention for children with asthma.[10] The experimental group was significantly higher than the control group ($p < 0.008$) on topics related to asthma and health behavior. Statistically significant changes were not found in the psychological tests. Huss et al. reported a significant decrease in dust mite allergens on bedroom carpets ($p = 0.004$) for an experimental group following interaction with a computer-based education program on mite avoidance.[11,12] Fisher et al. evaluated the effectiveness of computer based instructions for collecting a clean voided urine specimen.[13] The group receiving the computer-based education had lower bacterial counts than the group with written instruction ($P < 0.03$).

The purpose of this study was to determine the effectiveness of a personal computer-based expert system for disseminating information to ambulatory women with urinary incontinence for informed decision making. The expert system contained the knowledge domain taken from the AHCPR Urinary Incontinence guideline and behavioral treatments from the research literature. Consumer outcomes measured were number of incontinent episodes reported in a bladder diary and changes in psychosocial measures.

METHODS

Research Design and Hypotheses

A randomized controlled trial with two experimental groups and one control group was utilized. Subjects in the experimental groups

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received information from an expert system with handout or the AHCPR patient guideline booklet with handout. The control group viewed a general health video. The following hypotheses associated with consumer outcomes for the groups were proposed.

1. The expert system and the booklet groups will have a greater decrease in mean urinary incontinence episodes after receiving the intervention than subjects in the control group.
2. The expert system and the booklet groups will have a greater decrease in mean Incontinence Impact on Life measurements after receiving the intervention than subjects in the control group.
3. The expert system group will have lower mean urinary incontinence episodes after receiving the intervention than the booklet group.
4. The expert system group will have lower mean Incontinence Impact on Life measurements after receiving the intervention than the booklet group.

The dependent variables for the study were urinary incontinence episodes and impact on life measures. The dependent variables were measured three times in the study: (a) two weeks prior to the intervention, (b) two weeks post-intervention, and (c) four to six weeks post-intervention.

Expert System Development

VP-EXPERT ®, Version 3.0, trademark WordTech Systems, Inc., was utilized as the expert system shell software.[14] The software operated on a 386 IBM compatible computer with a VGA color monitor and mouse. Knowledge specific to the domain of urinary incontinence was obtained from the AHCPR published guideline and from published research literature about behavioral techniques.[6,7] From these sources, information was derived, refined, and organized for representation in the expert system, called the Urinary Incontinence Consultation System (UICS). Bladder training and pelvic muscle exercises were offered as the first treatment alternative for urinary incontinence without risk. Knowledge for the expert system was represented through the use of hypertext interface and production rules. The hypertext interface used "chunks" of knowledge to allow whatever word or phrase chosen to bring forth the information to the computer screen.[15] Chunks of knowledge were linked to each other in a defined manner determined by the author of the expert system. When using hypertext, the reader was able to jump from one chunk of knowledge to another non-sequentially. Production rules were IF-THEN statements, described by Turban as condition-action pairs.[16] Each production rule was an autonomous piece of knowledge. The goal was for all rules to work synergistically in arriving at a solution to an individualized problem. For example, if the subject had more than one type of incontinence, the rules provided advise for all conditions.

Testing the Expert System. The researcher tested the UICS with urinary incontinence cases to determine reliability and consistency in advice given by the expert system using procedures suggested by Schoolman.[17] Sensitivity was measured by the ability of the UICS to determine a type of urinary incontinence based on symptom input. To test for specificity, the knowledge domain in the UICS expert system was limited to expert knowledge stated in the AHCPR guideline and behavioral treatment research literature. As evidence of robustness, the same output was provided by the UICS expert system regardless if the user was an expert or non-expert.

Validity and Reliability. Addressing expert system validity testing according to Marcot and O'Keefe et al., four gerontological nurse experts and one nurse knowledgeable in expert systems reviewed the system and handouts for validity.[18,19] The nurse reviewers rated adjectives reflecting information value dimensions empirically tested by Zmud.[20] Adjectives used to measure each dimension were: (a) sufficient, (b) accurate, (c) current, (d) readable, and (e) useful. Validity testing for the expert system and handout used in the study indicated 80% agreement by the nurse experts that the information was sufficient for educating the health care consumer and 60% agreement that the information was readable. The expert nurses reported 100% agreement that information in the expert system and handout was accurate, current, and useful for the intended users of ambulatory women with urinary incontinence. The trace function within VP-EXPERT displayed the reliability of the expert system by giving consistent results to test cases.

Subjects

The population for the study included only ambulatory, alert, community dwelling women with urinary incontinence defined as accidental urine loss at least twice a week. Subjects were recruited from the population of healthy ambulatory women in the west central Florida region. Subjects responded to local paper and television advertisements. The subjects were

randomly assigned to one of three groups using block randomization. Sixty women, with a mean age of 55 years, were randomly assigned to one of the three groups. Inclusion criteria for subjects were defined as (a) accidental urine loss at least twice a week, (b) ambulation without difficulty, (c) nondependence on an urinary catheter, and (d) successful completion of a mental competency test.[21]

Instruments

A three day bladder diary, developed by the researcher, was used by the subjects to record urinary incontinence episodes in two hour block time frames for each day. Self-recording of voiding on a bladder diary was reported in previous research studies as an effective tool for urinary incontinence studies involving bladder diary results for outcome variables.[22,23] The Incontinence Impact on Life Questionnaire, adapted from Wyman et al. and Norton contained items to measure the impact of urinary incontinence for three broad areas: (a) activities of daily living, (b) social interaction, and (c) self-perception.[24,25]

Procedure

All subjects completed a three day bladder diary and impact on life questionnaire two weeks before receiving an intervention and two and six weeks after. Subjects received the intervention on an individual basis in one of two cities 35 miles apart. Informed consent was obtained from each subject prior to receiving the randomly assigned intervention. After receiving one of the three interventions, subjects in all three groups were given folders with bladder diaries and Incontinence Impact on Life questionnaires to complete and mail to the researcher two and six weeks later. Subjects in the control group returned to the researcher following completion of all forms. These subjects were given the option to receiving urinary incontinence and behavioral technique information from the expert system or the booklet.

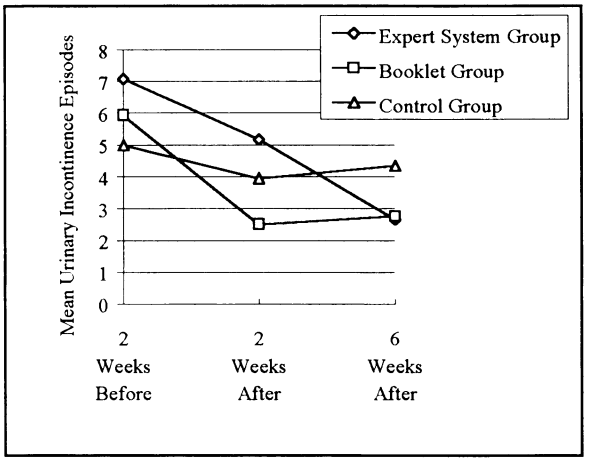
RESULTS

Sixty subjects ranging in age from 27-85 years completed the study, with a mean age of 55. The mean years of education was 14.14. There was no statistical significance between groups for age or education. Twenty-two subjects were in the expert system and handout group, 18 in the booklet and handout group, and 20 in the control group. A multivariate repeated measures analysis of variance procedure was used to analyze changes in the dependent variables within the subjects, differences between the groups, and within subject by between subject interaction. Each hypothesis is discussed with statistical analyses.

Hypothesis One

The expert system and the booklet groups were hypothesized to have a greater decrease in mean urinary incontinence episodes after receiving the intervention than subjects in the control group. There was a significant change in reported mean urinary incontinence episodes within subjects over time, (p = .0001). In addition the mean rate of change (decrease) in urinary incontinence episodes was significantly different between the groups, (p = .0269). Mean scores are displayed in Figure 1.

Figure 1. Mean Urinary Incontinence Episodes



Hypothesis Two

The expert system and the booklet groups were hypothesized to have a greater decrease in mean Incontinence Impact on Life measurements after receiving the intervention than subjects in the control group. A multivariate repeated measures analysis of variance revealed a significant change within subjects, (p = .0151). However, the rate of change was not significant between the groups, (p = .5084), indicating no difference in the rate of change for the three groups.

Hypothesis Three

The expert system group was hypothesized to have lower mean urinary incontinence episodes after receiving the intervention than the booklet group. While both experimental groups experienced a significant change in mean urinary incontinent episodes (p = .0001), the rate of change was not

significantly different between the two groups, (p = .1242).

Hypothesis Four

The expert system group was hypothesized to have lower mean Incontinence Impact on Life measurements after receiving the intervention than the booklet group. Mean score comparisons between pre-intervention and first post-intervention were significant, (p = .0328). No significance was reported for mean score comparisons between first and second post-intervention, (p = .1304).

CONCLUSIONS

Subjects in the two experimental groups reported a significant decrease in the number of urinary incontinence episodes. The experimental group that received the AHCPR guideline and behavioral treatment information for urinary incontinence through an interactive session with an expert system on a personal computer was just as effective in improving consumer outcomes as receiving the information from a booklet and consultation session. The concept of an expert system on a personal computer was supported as an effective dissemination strategy for expert knowledge.

The experimental groups and the control group were not significantly different for reported mean scores on items related to the impact of urinary incontinence on womens' lives. These findings align with recent studies that indicate the psychological impact of incontinence may be less than previously thought.[26]

The findings from this study meet the vision of the AHCPR guideline and Healthy People 2000 to disseminate health care treatment alternatives to consumers for informed decision making. Disseminating urinary incontinence information from clinical experience and research literature through an expert system gives the consumer a non-embarrassing way to obtain information for a personal problem. Both groups learned the "how to" for behavioral techniques, facilitating adopting the least invasive treatment alternative. The consequence for adopting the innovation were decreased urinary incontinence episodes.

Updating an expert system with the latest research information is easier than redeveloping publication. Expert systems may contain larger amounts of information than a booklet and are easier and less time consuming to search, as exemplified by the use of hypertext. However, the benefits of using a booklet over the expert system are convenience and simplicity. A clinician can provide the booklet in any setting whereas a personal computer is needed for an expert system. In summary, this study provided one major outcome: a personal computer-based expert system can be used to disseminate the AHCPR guideline and behavioral techniques to ambulatory women with an outcome of decreased urinary incontinence episodes. Computer technology can be used as a means of providing health related information to consumers for informed decision making.

IMPLICATIONS

Interactive computer technology in the form of an expert system can help consumers consult and learn about treatment alternatives for urinary incontinence. The interaction helps the consumer to organize thoughts prior to meeting with the health care provider. This has implications for less time spent with providers while improving autonomous consumer decision making. This study contributes to an evolving body of knowledge where the value of the consumer role in health care decisions is enabled through the use of computer technology. This field of study has multiple implications for third party payers, managed care, health maintenance organizations, and Internet options. Studies for improved outcomes at a lower cost and greater consumer satisfaction are possible as consumers are adequately informed of treatment alternatives from expert knowledge without the cost of expert time.

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